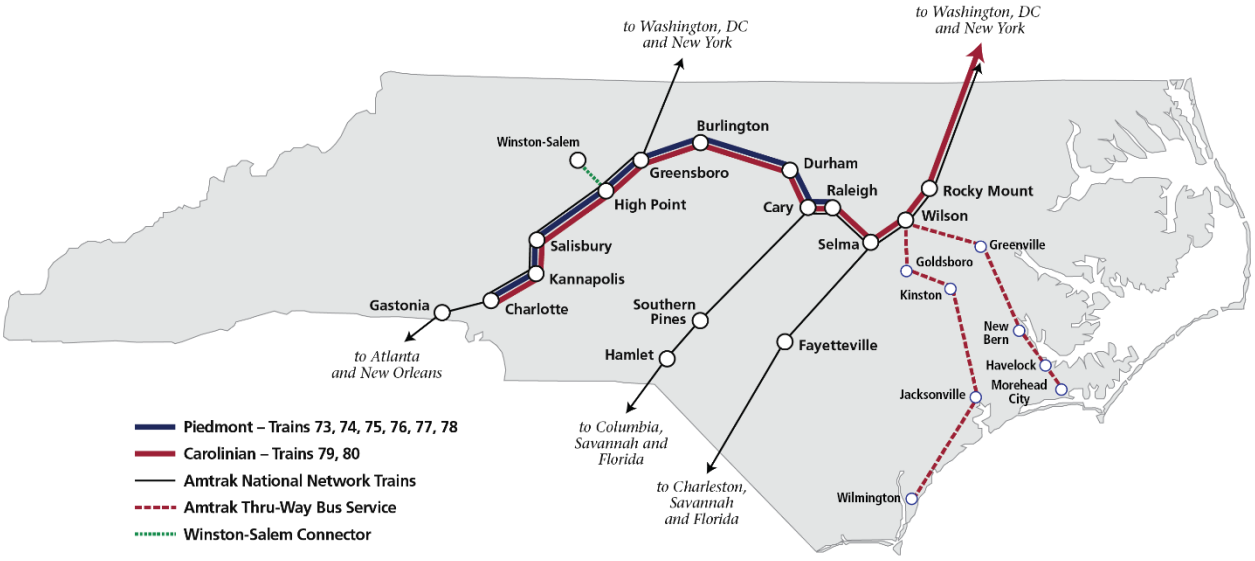

Piedmont Corridor Schedule Improvements

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February 2019

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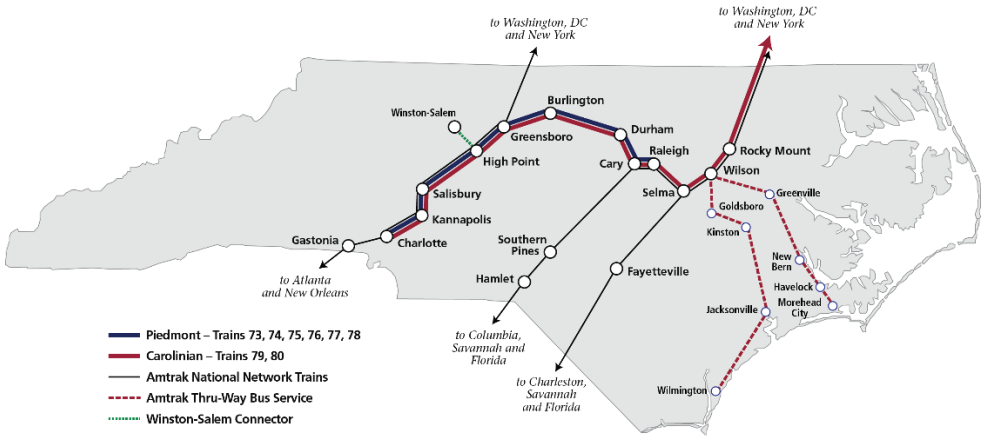
Summary

In response to a request by the Regional Transportation Alliance (RTA), the NCDOT Rail Division is providing this report on potential methods and considerations for reducing intercity passenger train service travel time between Raleigh and Charlotte.

The current intercity passenger train schedules are negotiated with Amtrak, Norfolk Southern, and the North Carolina Railroad Company. Modifying the schedules to reduce the effective travel time between endpoints would require coming to an agreement with the railroads. This report focuses on the possible opportunities to reduce that travel time acknowledging negotiations would be required with the railroads to operate with faster schedules.



There are multiple ways to consider decreasing the effective travel time of the *Piedmont* services to create a faster service. One way to decrease travel time is to reduce the number of station stops. In this analysis, when two representative station stops were omitted, NCDOT's analysis indicates actual travel time could be reduced by about 4 to 5 minutes for each station location. NCDOT's current ridership model predicts omitting two stations on certain trains could decrease total ridership on the *Piedmont* service by approximately 4 to 6 percent and a loss of annual revenue of approximately $250-$300K. Additionally, one of the major benefits of the state-supported train service is to provide an efficient and equitable connection between rural and urban centers. As such, NCDOT must carefully consider reduction in service to stations in efforts to reduce overall schedule time. To lessen impact to these services, express service using reduced station stops has been planned with introduction of Southeast Corridor future trains beyond the committed fourth *Piedmont* round trip anticipated in the next several years. Conceptually, up to four station stops could be omitted for some future Piedmont or Southeast Corridor trips.

Table 1 provides the schedule components of existing *Piedmont* Service with all 7 intermediate station stops.

Estimated Piedmont Schedule Components
2 hours, 26 minutes (est. pure run time, 2018)
32 minutes (intermediate station stops)
12 minutes (recovery/buffer)
3 hours, 10 minutes (Current Schedule Time)

Table 1: Travel Time Detail

Other methods can be employed to reduce travel time beyond limited station stops. Generally, reductions may occur due to improvements to operating practices or investments in capital improvements that directly improve travel times as outlined in the following table. Options include implementing higher cant deficiency operation (running faster) through curves, realignment of slow speed curves areas, and the reduction of individual causes of delay. These various incremental travel time improvements are summarized in Table 2.

Options for Improvement	Estimated Potential Time Savings	Potential Capital Cost
• Station grade crossing activation improvements	2 minutes	Low
• Higher speed through curves	5 minutes	Low
• Railroad alignment improvements	5 minutes	High
• New rolling stock technology	5 minutes	High
• 90 MPH maximum speed	5 minutes	High
Total Estimated Potential Time Savings	**Approximately 22 minutes***	

Table 2: Options for Travel Time Improvement

* Actual time savings would be evaluated with railroad partners to determine appropriate schedule adjustments.

NCDOT is currently focused on working with our railroad partners to improve schedule reliability of the current service as a target for increasing ridership. Schedule reliability has been a challenge, particularly over the last few years. Target end point on-time performance for the Piedmont Corridor is 80% or better and NCDOT is working with the railroads to meet or exceed this target.

Schedule reliability is important for ridership, particularly for time sensitive business travelers. Recovery or buffer time built into the schedule helps to alleviate normal delays enroute. Some of the travel time improvement opportunities discussed in this report could be used in part to ensure a reliable train service in addition to reducing the train schedule. This is especially important as new stations and corresponding stops are under development along the route to increase the reach of intercity rail service to additional communities.

Historical Improvements and Peer Comparison

Since 1990, with the introduction of the permanent *Carolinian* service, NCDOT has invested in the North Carolina Railroad Company corridor between Charlotte and Selma to make incremental travel time and frequency improvements for intercity passenger rail service. In 1995, the scheduled travel time on the *Piedmont* between Raleigh and Charlotte was 3 hours 45 minutes with significant reliability challenges resulting in typical travel times over 4 hours. Today, the scheduled service is 3 hours 10 minutes to Charlotte and 3 hours 11 minutes to Raleigh. Comparing the 1995 and 2018 timetables shows improvements have resulted in travel time improvements of 35 minutes with effective average speeds having increased from 46 to 55 miles per hour (mph).

As part of development of the Southeast Corridor (SEC) since the 1992 Federal designation, NCDOT has improved the safety, capacity, and functionality of every mile of the route between Charlotte and Raleigh. These capital improvements have been in the form of railroad realignments, introduction of modern signal systems, additional passing sidings, track structure upgrades, and junction reconfigurations. The incremental investments culminated in NCDOT's successful grant application for

High Speed Intercity Passenger Rail (HSIPR) program funding from USDOT in 2010. NCDOT's State Transportation Improvement Program (STIP) includes additional capacity and safety investments to continue to improve the corridor. In addition to capital investment, NCDOT's agreements with Norfolk Southern Corporation (NS) and the North Carolina Railroad Company (NCRR) include an NCDOT incremental contribution to the NS maintenance-of-way program to ensure NCDOT's historic program does not deteriorate with the passage of time.

The investment in capital improvement and maintenance has increased service frequency and raised the effective speed of the *Piedmont* route to competitive levels with its national peers. Characteristics of the *Piedmont* route and similar peer services are presented Table 3. The average speed of these peers is approximately 51 mph. As a note, none of these services provide express service that bypass existing stations on the state-supported route.

Route	Timetable Schedule (Hrs.)	Length (Miles)	Timetable Speed (MPH)	Number of Round Trips	Number of Stations
Cascades (Washington)	3.5	187	53.4	4	8
Downeaster (Maine)	2.5	115	46.0	5	9
Hiawatha (Wisconsin)	1.5	82	54.7	7	5
Lincoln (Illinois)	5.3	268	50.3	4	11
Missouri River Runner	5.7	271	47.8	2	10
Piedmont	3.2	173	54.6	3	9
		Average	50.6		

Table 3: Peer Routes Comparison

Speed Improvements

Express Service

Average speeds could be raised and travel times reduced by decreasing the number of station stops on selected trains. To date, limiting passenger station stops was planned primarily with the future introduction of Southeast Corridor intercity passenger rail service via the restored S-line between Richmond and Raleigh. This was reflected in the Federal Railroad Administration's (FRA) "Transportation Planning for the Richmond to Charlotte Corridor", completed in 2004[1], and later studies, such as the Southeast High Speed Rail Raleigh to Richmond Environmental Impact Statement (EIS).[2] Omitting station stops before the SEC additional service is available could benefit shorter distance trains traveling locally in North Carolina. The only interstate train which could eliminate stops is the *Carolinian*, but, as this service provides the only connectivity for smaller North Carolina stations to Virginia and the Northeast Corridor, this report does not contemplate operating this service without all intermediate station stops. Reducing travel connections for smaller communities to express destinations may provide additional utility to express service users, but the effect to ridership due to the reduction in access to out of state destinations from these communities could outweigh the express users' additional use of the express service. Furthermore, express service should be targeted at important arrival times in

[1] https://www.fra.dot.gov/Elib/Document/1308 & https://www.fra.dot.gov/Elib/Document/2755
[2] https://connect.ncdot.gov/resources/Rail-Division-Resources/Documents/SEHSR%20Raleigh%20to%20Richmond%20Signed%20Record%20of%20Decision.pdf

markets being served. Express service providing enhanced arrivals at inconvenient arrival/departure times would be of limited utility, such as a train arriving too close to mid-day or leaving too late in the day for the express benefit to be realized. A conceptual express service on the *Piedmont*, could mirror the station stops contemplated in the future by some Southeast Corridor services.

Possible interim express service on the *Piedmont* could provide earlier daily service in the major markets served, such as the Triangle, Greensboro, and Charlotte. If two stations were omitted, as studied in the EIS, train performance calculation modeling indicates that a one-way *Piedmont* trip could save 9 minutes, moving the typical arrival into Charlotte or Raleigh 9 minutes earlier for each affected one-way trip. Each station stop consumes 4 minutes or more, including 1 minute of dwell per station, at least 1 minute of additional time spent braking the train, and 2 minutes or more spent accelerating from the station to maximum authorized speed.

Current Service with Conceptual Express Modifications

NCDOT and Amtrak currently use the following schedule:

Southbound	73	75	77	79
Raleigh	6:30 AM	10:00 AM	3:00 PM	5:16 PM
Greensboro	8:01 AM	11:31 AM	4:31 PM	6:58 PM
Charlotte (ar)	9:40 AM	1:10 PM	6:10 PM	8:42 PM

Northbound	80	74	76	78
Charlotte	6:45 AM	10:30 AM	3:15 PM	7:00 PM
Greensboro	8:24 AM	12:03 PM	4:48 PM	8:33 PM
Raleigh (ar)	10:05 AM	1:41 PM	6:26 PM	10:10 PM

Table 4: Current Piedmont Schedule

If NCDOT were to propose the use of express service with the existing schedule, trains that might use the service pattern could be Trains 76 and 77, as well as Train 73. This would provide a shorter trip home at the end of a day in Charlotte or Raleigh, as well as earlier arrivals into Charlotte on Train 73. Express service on Trains 79 or 80 is not recommended due to the need to connect all stations to Virginia and the Northeast Corridor. This conceptual express service schedule is outlined in Table 5.

Concept A - Future Express with four round trips

Southbound	**73**	75	**77**	79
Raleigh	**6:30 AM**	10:00 AM	**3:00 PM**	5:16 PM
Greensboro	**7:57 AM**	11:31 AM	**4:27 PM**	6:58 PM
Charlotte (ar)	**9:31 AM**	1:10 PM	**6:01 PM**	8:42 PM

Northbound	80	74	**76**	78
Charlotte	6:45 AM	10:30 AM	**3:15 PM**	7:00 PM
Greensboro	8:24 AM	12:03 PM	**4:43 PM**	8:33 PM
Raleigh (ar)	10:05 AM	1:41 PM	**6:17 PM**	10:10 PM

Table 5: Current Schedule with Example Express Timing

NCDOT maintains a ridership model developed by AECOM in 2013 for predicting patronage on the Southeast Corridor in the future. Using this model, ridership and revenue are predicted to decline by 6.5 percent if the reduction in service occurred at the two stations. This reduction in revenue would translate to approximately $300,000 in lost revenue if early results from the new schedule of *Piedmont* service translates to a full year.

Future Additional Round Trip with Express Service

In the future, NCDOT's agreements with NS and NCRR allow for one additional full round trip to be added between Raleigh and Charlotte. It is currently anticipated that this trip will begin in the next few years. The analyzed schedule for this new service is summarized in Table 6, below. This schedule is being further evaluated to attract morning and evening business travel patterns to major destinations along the route.

Southbound	71	73	75	79	77
Raleigh	6:00 AM	9:15 AM	12:00 PM	5:16 PM	7:35 PM
Greensboro	7:31 AM	10:46 AM	1:31 PM	6:58 PM	9:06 PM
Charlotte (ar)	9:05 AM	12:20 PM	3:05 PM	8:42 PM	10:40 PM

Northbound	80	72	74	76	78
Charlotte	6:45 AM	9:35 AM	2:35 PM	5:10 PM	7:45 PM
Greensboro	8:20 AM	11:06 AM	4:06 PM	6:41 PM	9:16 PM
Raleigh (ar)	10:05 AM	12:46 PM	5:41 PM	8:21 PM	10:51 PM

Table 6: Example Fifth Round Trip Schedule

NCDOT could consider modification to this schedule to create express service on Trains 71, 72, and 76. Unlike in the current schedules, there is not a mid-afternoon train departing at 3:00 PM. This results in limited opportunities for express service. This conceptual express service schedule is summarized in Table 7.

Concept B – Future Express with Five Round Trips

Southbound	**71**	73	75	79	77
Raleigh	**6:00 AM**	9:15 AM	12:00 PM	5:16 PM	7:35 PM
Greensboro	**7:26 AM**	10:46 AM	1:31 PM	6:47 PM	9:06 PM
Charlotte (ar)	**8:56 AM**	12:20 PM	3:05 PM	8:12 PM	10:40 PM

Northbound	80	**72**	74	**76**	78
Charlotte	6:45 AM	**9:35 AM**	2:35 PM	**5:10 PM**	7:45 PM
Greensboro	8:20 AM	**11:01 AM**	4:06 PM	**6:36 PM**	9:16 PM
Raleigh (ar)	10:05 AM	**12:37 PM**	5:41 PM	**8:12 PM**	10:51 PM

Table 7: Example Fifth Round Trip with Express

Modeling the impacts of this proposed schedule change in the AECOM ridership model indicates ridership and revenue would decline by approximately 4.2 percent, or approximately $250,000 or more in lost revenue. This decline is anticipated to be somewhat offset by additional ridership due to the express schedule. However, no additional travel among the larger markets the *Piedmont* serves is predicted by the model. This ridership model is not designed to address the potential of intra-day

travelers to use the intercity service, so there may be additional ridership attracted to the service not reflected here. The effect on ridership due to reducing the number of station stops will be further evaluated in subsequent studies.

Study of Shorter Travel Time

Planning for the Southeast Corridor has included additional improvements to the NCRR corridor beyond the improvements completed since 1990 and programmed in NCDOT's current 2018-2027 STIP. Future improvements beyond the programming horizon of the STIP include average, minimum, and maximum speed increases on the NCRR corridor, as well as better reliability through additional capacity, reduction in vehicle and trespasser-related incidents, and future technology initiatives to assist the corridor in handling additional train volumes.

Improvements to maximum speeds include addressing areas of the corridor where the maximum authorized speed is less than the speed for which the track is maintained, and investigation of the potential for raising the maximum authorized speed for regular travel beyond the current regulatory track-class limit of 79 mph. Many areas of the corridor have horizontal curvature deficiencies that limit maximum speeds well below 79 mph.

Grade Crossing Activation Improvements

Current operating practice on the NCRR corridor includes track circuit activation of all grade crossings protected with equipment such as flashing lights and gates. At certain stations along the NCRR corridor there are grade crossings near station platforms with circuits that do not activate while passengers are boarding and alighting. This situation occurs today at Kannapolis, Salisbury, Greensboro, Burlington, Durham, and Cary. When the train is ready for departure from the station, the train engineer must operate the train at very slow speed ensuring that the crossing track circuit activates the crossing warning devices. Once the gates are fully down the engineer may then increase power and begin to accelerate to civil speed. This operating practice has been remedied in other areas of the United States with additional equipment on board locomotives and at crossing signal cabinets for train engineers to send a coded radio message to the crossing signal equipment to activate the crossing hardware prior to departure. Allowing the engineer to send this message just before departing the station would save time at each of these stations, estimated at 2-3 minutes per one-way *Piedmont* trip.

Higher Speeds Through Curves

A straightforward way to reduce travel time is increasing the speed of the rail equipment through curves. Rail equipment may travel around horizontal curves faster than the balanced equilibrium speed dictated by the super-elevation (banking) around a curve at a given speed. The differential between the curve authorized speed and the equilibrium speed is often indicated as the additional super-elevation not installed on a curve, due to the need to maintain a curve's compatibility with lower speed train operations, such as those of freight trains. This unbalanced tilt is known as cant deficiency, and in the United States, is expressed in inches. Currently NS and NCRR permit *Piedmont* and *Carolinian* equipment to operate at 3 inches of cant deficiency. On CSX track in eastern NC and Virginia, the *Carolinian* equipment operates at 4 inches of cant deficiency. In other regions, additional cant deficiency is also used by passenger trains, such as 5 inches on the *Cascades* route with advanced tilting technology. Changing the operating practice on the corridor from 3 inches of cant deficiency to 4 inches would allow *Piedmont* and *Carolinian* trains to travel around certain curves at approximately 5 mph faster,

particularly on the curvy Raleigh to Greensboro segment. Of the needed speed increases identified above, increasing the cant deficiency from 3 inches to 4 inches may decrease trip times by 5 minutes.

New Rolling Stock Technology

NCDOT began developing its own rolling stock fleet in the early 1990s for the introduction of the *Piedmont* service in 1995. Since then, NCDOT has purchased over forty units of equipment built between 1953 and 1998 to support today's three daily *Piedmont* trips and the additional trip planned for 2021. In the future, NCDOT is planning to replace its fleet as equipment finishes its useful life and to add additional *Piedmont* and Southeast Corridor trips. When these purchases must be made, NCDOT may be able to incorporate new rolling stock that would accelerate and decelerate faster than the current equipment.

Currently the *Piedmont* uses one or two EMD F59 type locomotives with conventional trailing, non-powered coaches and lounge/baggage cars. The acceleration and deceleration performance of this equipment is less compared to multiple unit equipment where every other axle has a traction motor with many smaller diesel engines powering the traction motors. Recent examples of this type of equipment in the United States include the Nippon Sharyo diesel multiple unit deployed on the new Sonoma-Marin commuter system and the Stadler Rail FLIRT being constructed for the TEX Rail project between downtown Ft. Worth, Texas and Dallas-Fort Worth airport. Adding horsepower to a consist through many smaller engines may impact the economics of train operations, as fuel consumption increases with unit additions to a train faster than for locomotive hauled trains. It is estimated that implementing this type of equipment could decrease the travel time by approximately 5 minutes by improving acceleration and deceleration performance into and out of stations and other slow segments of the corridor.

Railroad Alignment Improvements

The alignment of the portion of the corridor extending from Greensboro through Durham and Cary has largely not been improved over its original 1849 development. There are many areas of curves where the speed is restricted to 45 mph or less, which is a significant difference from the 79 mph maximum authorized speed. In order to improve travel times on the entire corridor, this segment of railroad should receive special consideration for capital improvements. The result of the significant acceleration and deceleration necessary for sharp civil speed reductions is an inefficient operation where trains are unable to take advantage of adjoining full speed sections of track, resulting in 5 minutes or more of lost time per one way trip, solely due to the minority of the route between Greensboro and Cary. Select realignments on this corridor would have the effect of raising the average speed and would support future increases in maximum authorized speed.

There is also a benefit of realigning the corridor to operations with the implementation of positive train control (PTC). PTC can have the effect of increasing the run time in lower speed segments of the corridor with many slow speed curves. This is due to PTC including a calculated margin of safety to address the reaction time of the train engineer, which moves braking from a 'critical' point before a curve to an earlier point in time. In other words, the train must brake further away from lower speed curves, which adds to the schedule time. This factor highlights the importance of projects that reduce sharp curves and their associated speed restrictions, particularly on the very curvy alignment of the corridor between Greensboro and Cary.

Increasing Maximum Authorized Speed

Increasing the maximum authorized speed of the corridor beyond 79 mph has been examined in several studies since the mid-1990s; however, such a change is dependent on additional negotiations with NCRR and NS. Increasing maximum authorized speed to 90 mph in the 2004 FRA Study involved a scenario that also included tilting equipment, but reduced travel by 14 minutes relative to the improved scenario discussed above at 2 hours, 21 minutes. NS' current policy does not consider operations above 79 mph in freight/passenger shared-use corridors.[3] In addition, operations at 90 mph have capital and maintenance costs, including improving grade crossing hardware. FRA track maintenance standards applicable to this situation include raising the track class from Class IV to Class V. Class V track includes tighter tolerances for gauge, tie condition, ballast condition, and other engineering constraints. Under NCDOT's agreements with NS and NCRR, additional ongoing maintenance contributions from NCDOT would likely be required.

Appropriate Station Spacing

In NCDOT's planning for additional intercity passenger rail service, station spacing has always been a major consideration. Understanding the impact of a station on a train's travel time compared to a station's ability to attract additional riders to a service, most services opt for additional stations rather than incrementally faster train service. NCDOT has planned for train station spacing of approximately 17 miles as an appropriate distance to ensure trains can spend time at their maximum authorized speed between stations and to provide appropriate access to the rail service for all communities.

Based on the current corridor characteristics between Raleigh and Charlotte and this guiding distance, NCDOT has been supporting communities developing additional stations, including station stops at Hillsborough, Lexington, and Harrisburg. Each of these may add 4-5 minutes to the *Piedmont*'s run time. In addition, NCDOT and the City of Charlotte are funding a new Gateway station in Uptown Charlotte at Trade Street, which will provide improved connections to locations around Uptown and adds approximately 3 minutes of additional travel time to the route of the *Piedmont* to travel farther into Charlotte. Some of the speed improvements discussed above (additional cant deficiency, curve realignments, etc.) could be used to offset the travel time for additional station stops.

Conclusion

NCDOT is committed to providing improved trip times for *Piedmont* and *Carolinian* service customers, in line with our mission of providing efficient and reliable connections to all users along the I-85/I-40 corridor between Raleigh and Charlotte. Schedule reliability has been a challenge over the past year as freight and passenger traffic is growing, and any modifications to schedules should ensure that customers can reliably reach their destination on time. Express service with limited station stops has historically been planned as a component of the schedule when additional Southeast Corridor roundtrips are added beyond the first five roundtrips. NCDOT recognizes that connections between smaller stations and population centers provided by the current Piedmont and Carolinian service supports the Department's mission and goals by directly connecting smaller communities in our state with job centers. Removing station stops from this service in the near-term could decrease the connectivity of the system without significant travel time benefits. NCDOT will continue to pursue all

[3] http://i26alt.org/wp-content/uploads/APPENDIX_3C_Freight-Railroad-Policies.pdf, p. 10.

potential travel time improvements, in coordination with our railroad partners, as means to improve the reliability and reduce the schedule time of the existing service.

As a next step, NCDOT will begin additional detailed study of the proposed Piedmont schedule for the upcoming five round trip schedule, in addition to further evaluating limiting station stops for some trains. The analysis will evaluate the effect on ridership and revenue for a number of scenarios including the effect of adding stations and modification of schedules to further attract regular business travelers.